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60544172	Not Issued	020	02/11/2004	SUBSURFACE SCATTERING APPROXIMATION METHODS AND APPARATUS	LOKOVIC, THOMAS
10810064	Not Issued	020	03/25/2004	SUBSURFACE SCATTERING APPROXIMATION METHODS AND APPARATUS	LOKOVIC, THOMAS
10686551	Not Issued	030	10/14/2003	METHOD AND APPARATUS FOR RENDERING SHADOWS	LOKOVIC, THOMAS DAVID
09619064	6760024	150	07/19/2000	METHOD AND APPARATUS FOR RENDERING SHADOWS	LOKOVIC, THOMAS DAVID

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<u>60442384</u>	Not Issued	159	01/24/2003	METHOD FOR AUTOMATICALLY LIMITING ADVERTISEMENTS	VEACH, ERIC HUGH
<u>60442209</u>	Not Issued	159	01/24/2003	METHOD FOR ENCODING ADVERTISEMENT INFORMATION IN A CLICK URL	VEACH, ERIC
<u>60439361</u>	Not Issued	159	01/10/2003	ESTIMATING CLICK-THROUGH RATES	VEACH, ERIC
<u>60439354</u>	Not Issued	159	01/10/2003	METHOD AND APPARATUS FOR ESTIMATING ELECTRONIC ADVERTISING INVENTORY	VEACH, ERIC
<u>60439174</u>	Not Issued	159	01/10/2003	SETTING MINIMUM PRICES IN AN ADVERTISING SYSTEM	VEACH, ERIC
<u>60424792</u>	Not Issued	159	11/08/2002	AUTOMATED PRICE MAINTENANCE FOR USE WITH A SYSTEM IN WHICH ADVERTISEMENTS ARE RENDERED WITH RELATIVE PREFERENCE BASED ON PERFORMANCE INFORMATION AND PRICE INFORMATION	VEACH, ERIC
<u>60317847</u>	Not Issued	159	09/06/2001	METHODS AND APPARATUS FOR ORDERING ADVERTISEMENTS	VEACH, ERIC
<u>10877790</u>	Not Issued	030	06/25/2004	COST DISCOUNTING TO PROVIDE DOMINANT PARTICIPATION STRATEGY ARBITRATION FOR ONLINE	VEACH, ERIC

				ADVERTISING AND ARBITRATIONS SUPPORTING OFFERS FROM DIFFERENT COST DISCOUNTING METHODOLOGIES	
<u>10767880</u>	Not Issued	020	01/28/2004	METHOD AND APPARATUS FOR SURFACE APPROXIMATION WITHOUT CRACKS	VEACH, ERIC HUGH
<u>10749110</u>	Not Issued	020	12/29/2003	ENCODING AD AND/OR AD SERVING INFORMATION IN A CLICK URL	VEACH, ERIC
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<u>10686551</u>	Not Issued	030	10/14/2003	METHOD AND APPARATUS FOR RENDERING SHADOWS	VEACH, ERIC HUGH
<u>10610350</u>	Not Issued	030	06/30/2003	USING ENHANCED AD FEATURES TO INCREASE COMPETITION IN ONLINE ADVERTISING	VEACH, ERIC
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<u>10340543</u>	Not Issued	030	01/10/2003	AUTOMATED PRICE MAINTENANCE FOR USE WITH A SYSTEM IN WHICH ADVERTISEMENTS ARE RENDERED WITH RELATIVE	VEACH, ERIC

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<u>10340542</u>	Not Issued	030	01/10/2003	AUTOMATED PRICE MAINTENANCE FOR USE WITH A SYSTEM IN WHICH ADVERTISEMENTS ARE RENDERED WITH RELATIVE PREFERENCE BASED ON PERFORMANCE INFORMATION AND PRICE INFORMATION	VEACH, ERIC
<u>10340193</u>	Not Issued	030	01/10/2003	PRICING ACROSS KEYWORDS ASSOCIATED WITH ONE OR MORE ADVERTISEMENTS	VEACH, ERIC
<u>10164691</u>	Not Issued	041	06/06/2002	SYSTEM AND METHOD OF USING MULTIPLE REPRESENTATIONS PER OBJECT IN COMPUTER GRAPHICS	VEACH, ERIC
<u>10112654</u>	Not Issued	030	03/29/2002	METHODS AND APPARATUS FOR ORDERING ADVERTISEMENTS BASED ON PERFORMANCE INFORMATION AND PRICE INFORMATION	VEACH, ERIC
<u>09865990</u>	Not Issued	041	05/25/2001	SYSTEM AND METHOD OF LINE SAMPLING OBJECT SCENE INFORMATION	VEACH, ERIC
<u>09619065</u>	<u>6707452</u>	150	07/19/2000	METHOD AND APPARATUS FOR SURFACE APPROXIMATION WITHOUT CRACKS	VEACH, ERIC HUGH
<u>09619064</u>	<u>6760024</u>	150	07/19/2000	METHOD AND APPARATUS FOR RENDERING SHADOWS	VEACH, ERIC HUGH
<u>08922909</u>	<u>6081268</u>	150	09/03/1997	METHOD FOR IGNORING REDUNDANT CONSTRAINTS IN A GRAPHIC EDITOR	VEACH , ERIC H.

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1 Shadow volume reconstruction from depth maps

Michael D. McCool

January 2000 **ACM Transactions on Graphics (TOG)**, Volume 19 Issue 1

Full text available: pdf(385.75 KB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Current graphics hardware can be used to generate shadows using either the shadow volume or shadow map techniques. However, the shadow volume technique requires access to a representation of the scene as a polygonal model, and handling the near plane clip correctly and efficiently is difficult; conversely, accurate shadow maps require high-precision texture map data representations, but these are not widely supported. We present a hybrid of the shadow map and shadow volume approach ...

Keywords: hardware accelerated image synthesis, illumination, image processing, shadows

2 Precomputed radiance transfer for real-time rendering in dynamic, low-frequency lighting environments

Peter-Pike Sloan, Jan Kautz, John Snyder

July 2002 **ACM Transactions on Graphics (TOG) , Proceedings of the 29th annual conference on Computer graphics and interactive techniques**, Volume 21 Issue 3

Full text available: pdf(5.37 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We present a new, real-time method for rendering diffuse and glossy objects in low-frequency lighting environments that captures soft shadows, interreflections, and caustics. As a preprocess, a novel global transport simulator creates functions over the object's surface representing transfer of arbitrary, low-frequency incident lighting into *transferred radiance* which includes global effects like shadows and interreflections from the object onto itself. At run-time, these transfer functions ...

Keywords: Monte Carlo techniques, graphics hardware, illumination, rendering, shadow algorithms

3 Session E: Rendering: Forward area light map projection

Elvis Ko-Yung Jeng, Zhigang Xiang

February 2003 **Proceedings of the 2nd international conference on Computer graphics, virtual Reality, visualisation and interaction in Africa**

Full text available:  pdf(1.32 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


We present a new method for soft shadow visualization. This two-stage approach generates high-quality soft shadow images by projecting sampled surface points, which are kept in a "layered area light map", onto the viewing screen. The layered area light map is created in the preprocessing stage, and is multi-layered in the sense that each map cell keeps the visibility ratio of the area light source with respect to multiple surface points at varying depth. In the forward projection stage, we proje ...

Keywords: area light, rendering, shadow algorithm, soft shadow

4 A geometry-based soft shadow volume algorithm using graphics hardware

Ulf Assarsson, Tomas Akenine-Möller

July 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 3

Full text available:  pdf(4.95 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Most previous soft shadow algorithms have either suffered from aliasing, been too slow, or could only use a limited set of shadow casters and/or receivers. Therefore, we present a strengthened soft shadow volume algorithm that deals with these problems. Our critical improvements include robust penumbra wedge construction, geometry-based visibility computation, and also simplified computation through a four-dimensional texture lookup. This enables us to implement the algorithm using programmable ...

Keywords: graphics hardware, pixel shaders, soft shadows

5 Interactive shadow generation in complex environments

Naga K. Govindaraju, Brandon Lloyd, Sung-Eui Yoon, Avneesh Sud, Dinesh Manocha

July 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 3

Full text available:  pdf(2.63 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


We present a new algorithm for interactive generation of hard-edged, umbral shadows in complex environments with a moving light source. Our algorithm uses a hybrid approach that combines the image quality of object-precision methods with the efficiencies of image-precision techniques. We present an algorithm for computing a compact potentially visible set (PVS) using levels-of-detail (LODs) and visibility culling. We use the PVSs computed from both the eye and the light in a novel cross-culling ...

Keywords: interactive display, level-of-detail, parallel rendering, shadows, visibility

6 Efficient antialiased rendering of 3-D linear fractals

John C. Hart, Thomas A. DeFanti

July 1991 **ACM SIGGRAPH Computer Graphics, Proceedings of the 18th annual conference on Computer graphics and interactive techniques**, Volume 25 Issue 4

Full text available:  pdf(3.60 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Object instancing is the efficient method of representing an hierarchical object with a directed graph instead of a tree. If this graph contains a cycle then the object it represents is a linear fractal. Linear fractals are difficult to render for three specific reasons: (1) ray-fractal intersection is not trivial, (2) surface normals are undefined and (3) the object aliases


at all sampling resolutions. Ray-fractal intersections are efficiently approximated to sub-pixel accuracy using procedural ...

Keywords: covers, fractal, object instancing, procedural modeling, ray tracing

7 Texture-based visibility for efficient lighting simulation

Cyril Soler, F. X. Sillion

October 2000 **ACM Transactions on Graphics (TOG)**, Volume 19 Issue 4

Full text available:  pdf(1.71 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Lighting simulations using hierarchical radiosity with clustering can be very slow when the computation of fine and artifact-free shadows is needed. To avoid the high cost of mesh refinement associated with fast variations of visibility across receivers, we propose a new hierarchical algorithm in which partial visibility maps can be computed on the fly, using a convolution technique for emitter-receiver configurations where complex shadows are produced. Other configurations still rely on m ...

Keywords: convolution, global illumination, hierarchical radiosity, texture-based visibility

8 A progressive multi-pass method for global illumination

Shenchang Eric Chen, Holly E. Rushmeier, Gavin Miller, Douglass Turner

July 1991 **ACM SIGGRAPH Computer Graphics, Proceedings of the 18th annual conference on Computer graphics and interactive techniques**, Volume 25 Issue 4

Full text available:  pdf(5.76 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

A new progressive global illumination method is presented which produces approximate images quickly, and then continues to systematically produce more accurate images. The method combines the existing methods of progressive refinement radiosity, Monte Carlo path tracing and light ray tracing. The method does not place any limitation on surface properties such as ideal Lambertian or mirror-like. To increase efficiency and accuracy, the new concepts of light source reclassification, caustics recon ...

Keywords: Monte Carlo, Ray Tracing, caustics, global illumination, progressive refinement, radiosity

9 A language for shading and lighting calculations

Pat Hanrahan, Jim Lawson

September 1990 **ACM SIGGRAPH Computer Graphics, Proceedings of the 17th annual conference on Computer graphics and interactive techniques**, Volume 24 Issue 4

Full text available:  pdf(2.08 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

A shading language provides a means to extend the shading and lighting formulae used by a rendering system. This paper discusses the design of a new shading language based on previous work of Cook and Perlin. This language has various types of shaders for light sources and surface reflectances, point and color data types, control flow constructs that support the casting of outgoing and the integration of incident light, a clearly specified interface to the rendering system using global state var ...

10 3D texture: Shell texture functions

Yanyun Chen, Xin Tong, Jiaping Wang, Stephen Lin, Baining Guo, Heung-Yeung Shum

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Full text available:  pdf(1.40 MB) Additional Information: [full citation](#), [abstract](#), [references](#)

We propose a texture function for realistic modeling and efficient rendering of materials that exhibit surface mesostructures, translucency and volumetric texture variations. The appearance of such complex materials for dynamic lighting and viewing directions is expensive to calculate and requires an impractical amount of storage to precompute. To handle this problem, our method models an object as a shell layer, formed by texture synthesis of a volumetric material sample, and a homogeneous inner ...

Keywords: BTF, Texture mapping, mesostructure, reflectance and shading models, subsurface scattering, texture synthesis

11 Algorithms: Real-time shadows for animated crowds in virtual cities

Céline Loscos, Franco Tecchia, Yiorgos Chrysanthou

November 2001 **Proceedings of the ACM symposium on Virtual reality software and technology**

Full text available:  pdf(1.51 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In this paper, we address the problem of shadow computation for large environments including thousands of dynamic objects. The method we propose is based on the assumption that the environment is 2.5D, which is often the case for virtual cities, thus avoiding complex visibility computation. We apply our method for virtual cities populated by thousands of walking humans, which we render with impostors, allowing real time simulation. In this paper, we treat the cases of shadows cast by buildings on ...

Keywords: dynamic shadows, multi-texturing, populated virtual cities, real time rendering, shadow computation

12 Combining edges and points for interactive high-quality rendering

Kavita Bala, Bruce Walter, Donald P. Greenberg

July 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 3

Full text available:  pdf(4.52 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


This paper presents a new interactive rendering and display technique for complex scenes with expensive shading, such as global illumination. Our approach combines sparsely sampled shading (points) and analytically computed discontinuities (edges) to interactively generate high-quality images. The *edge-and-point* image is a new compact representation that combines edges and points such that fast, table-driven interpolation of pixel shading from nearby point samples is possible, while resampling ...

Keywords: interactive software rendering, silhouette and shadow edges, sparse sampling and reconstruction

13 Distributed ray tracing

Robert L. Cook, Thomas Porter, Loren Carpenter

January 1984 **ACM SIGGRAPH Computer Graphics, Proceedings of the 11th annual conference on Computer graphics and interactive techniques**, Volume 18 Issue 3

Full text available:  pdf(909.54 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Ray tracing is one of the most elegant techniques in computer graphics. Many phenomena that are difficult or impossible with other techniques are simple with ray tracing, including

shadows, reflections, and refracted light. Ray directions, however, have been determined precisely, and this has limited the capabilities of ray tracing. By distributing the directions of the rays according to the analytic function they sample, ray tracing can incorporate fuzzy phenomena. This provides c ...

Keywords: Camera, Constructive solid geometry, Depth of field, Focus, Gloss, Motion blur, Penumbras, Ray tracing, Shadows, Translucency, Transparency

14 Lighting & sampling: An approximate global illumination system for computer generated films

Eric Tabellion, Arnauld Lamorlette

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Full text available:  pdf(819.51 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Lighting models used in the production of computer generated feature animation have to be flexible, easy to control, and efficient to compute. Global illumination techniques do not lend themselves easily to flexibility, ease of use, or speed, and have remained out of reach thus far for the vast majority of images generated in this context. This paper describes the implementation and integration of indirect illumination within a feature animation production renderer. For efficiency reasons, we ch ...

Keywords: distributed ray tracing, global illumination, irradiance caching, micro-polygon, rendering

15 A final reconstruction approach for a unified global illumination algorithm

Xavier Granier, George Drettakis

April 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 2

Full text available:  pdf(4.41 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


In the past twenty years, many algorithms have been proposed to compute global illumination in synthetic scenes. Typically, such approaches can deal with specific lighting configurations, but often have difficulties with others. In this article, we present a final reconstruction step for a novel *unified approach* to global illumination that automatically detects different types of light transfer and uses the appropriate method in a closely-integrated manner. With our approach, we can deal ...

Keywords: Global illumination, density estimation, final gather, hierarchical radiosity with clustering, particle tracing

16 Steerable illumination textures

Michael Ashikhmin, Peter Shirley

January 2002 **ACM Transactions on Graphics (TOG)**, Volume 21 Issue 1

Full text available:  pdf(4.52 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We introduce a new set of illumination basis functions designed for lighting bumpy surfaces. This lighting includes shadowing and interreflection. To create an image with a new light direction, only a linear combination of precomputed textures is required. This is possible by using a carefully selected set of steerable basis functions. Steerable basis lights have the property that they allow lights to move continuously without jarring visual artifacts. The new basis lights are shown to produce i ...

Keywords: Bump mapping, displacement mapping, relighting, steerable functions, textures

17 Computational Approaches to Image Understanding

Michael Brady


January 1982 **ACM Computing Surveys (CSUR)**, Volume 14 Issue 1

Full text available:  pdf(10.04 MB) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

18 Texture mapping 3D models of real-world scenes

Frederick M. Weinhaus, Venkat Devarajan

December 1997 **ACM Computing Surveys (CSUR)**, Volume 29 Issue 4

Full text available:  pdf(1.98 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#), [review](#)


Texture mapping has become a popular tool in the computer graphics industry in the last few years because it is an easy way to achieve a high degree of realism in computer-generated imagery with very little effort. Over the last decade, texture-mapping techniques have advanced to the point where it is possible to generate real-time perspective simulations of real-world areas by texture mapping every object surface with texture from photographic images of these real-world areas. The technique ...

Keywords: anti-aliasing, height field, homogeneous coordinates, image perspective transformation, image warping, multiresolution data, perspective projection, polygons, ray tracing, real-time scene generation, rectification, registration, texture mapping, visual simulators, voxels

19 Three-dimensional object recognition

Paul J. Besl, Ramesh C. Jain

March 1985 **ACM Computing Surveys (CSUR)**, Volume 17 Issue 1


Full text available:  pdf(7.76 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

A general-purpose computer vision system must be capable of recognizing three-dimensional (3-D) objects. This paper proposes a precise definition of the 3-D object recognition problem, discusses basic concepts associated with this problem, and reviews the relevant literature. Because range images (or depth maps) are often used as sensor input instead of intensity images, techniques for obtaining, processing, and characterizing range data are also surveyed.

20 A Ray tracing algorithm for progressive radiosity

J. R. Wallace, K. A. Elmquist, E. A. Haines

July 1989 **ACM SIGGRAPH Computer Graphics , Proceedings of the 16th annual conference on Computer graphics and interactive techniques**, Volume 23 Issue 3

Full text available:  pdf(4.23 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

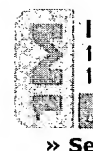
A new method for computing form-factors within a progressive radiosity approach is presented. Previously, the progressive radiosity approach has depended on the use of the hemi-cube algorithm to determine form-factors. However, sampling problems inherent in the hemi-cube algorithm limit its usefulness for complex images. A more robust approach is described in which ray tracing is used to perform the numerical integration of the form-factor equation. The approach is tailored to provide good, appr ...

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Computer Graphics International 2001. Proceedings , 3-6 July 2001

Pages:209 - 214

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